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Ingraham et al.

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(54) **RETRIEVABLE CEMENTING BUSHING SYSTEM**

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E21B 33/13 (2006.01)

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CPC ***E21B 33/12*** (2013.01); ***E21B 23/01*** (2013.01); ***E21B 33/13*** (2013.01)

(58) **Field of Classification Search**
CPC E21B 33/12; E21B 33/128; E21B 23/00; E21B 23/01; E21B 23/03
USPC 166/381, 382, 123, 125, 181, 174, 166/255.2, 242.7
See application file for complete search history.

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(57) **ABSTRACT**

A technique facilitates downhole service operations including cementing operations. A retrievable cementing bushing is designed to facilitate the service operation and includes a body on which is mounted an engagement lug. The engagement lug is mounted for movement in a radial direction and includes an outer engagement feature and an inner engagement feature. The inner engagement feature is oriented for cooperation with a slick joint. The engagement lug is biased in a radially outward direction for engagement with corresponding features of a surrounding wall.

9 Claims, 6 Drawing Sheets

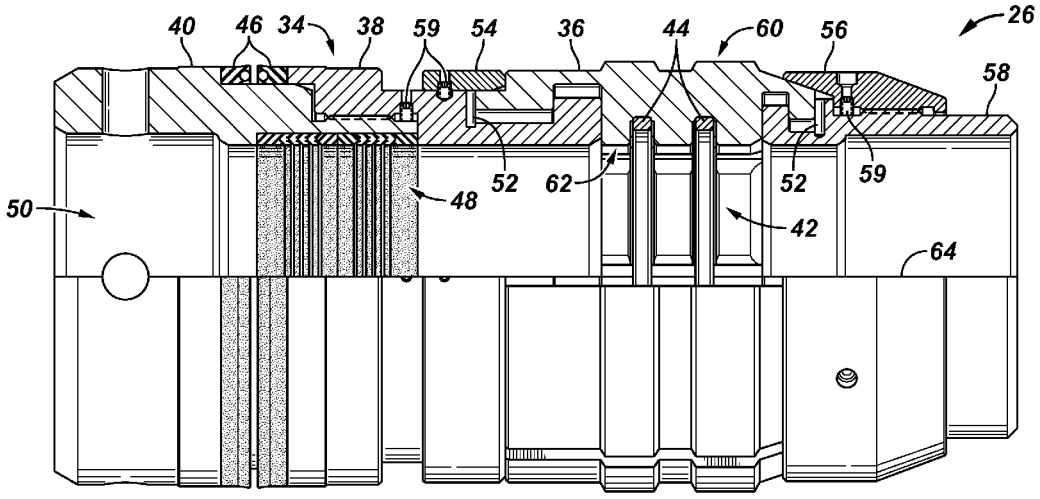
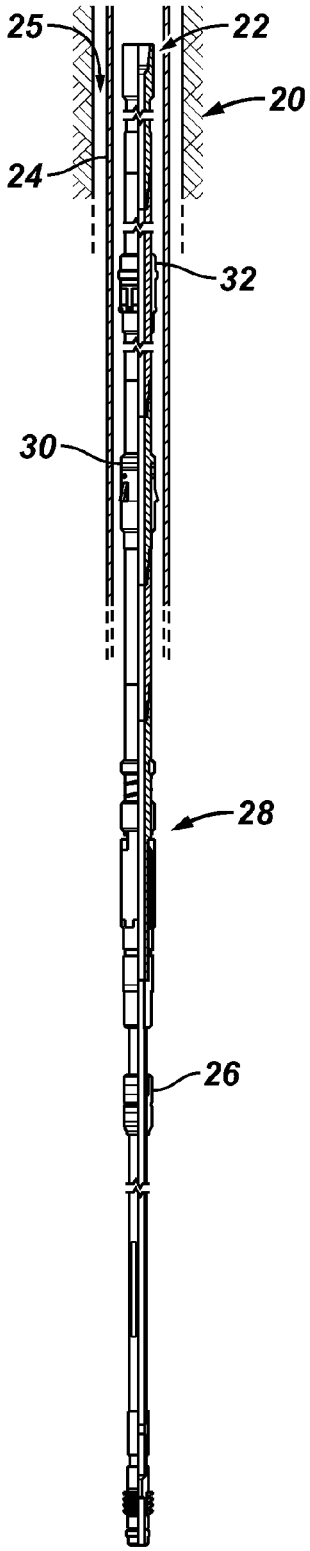


FIG. 1



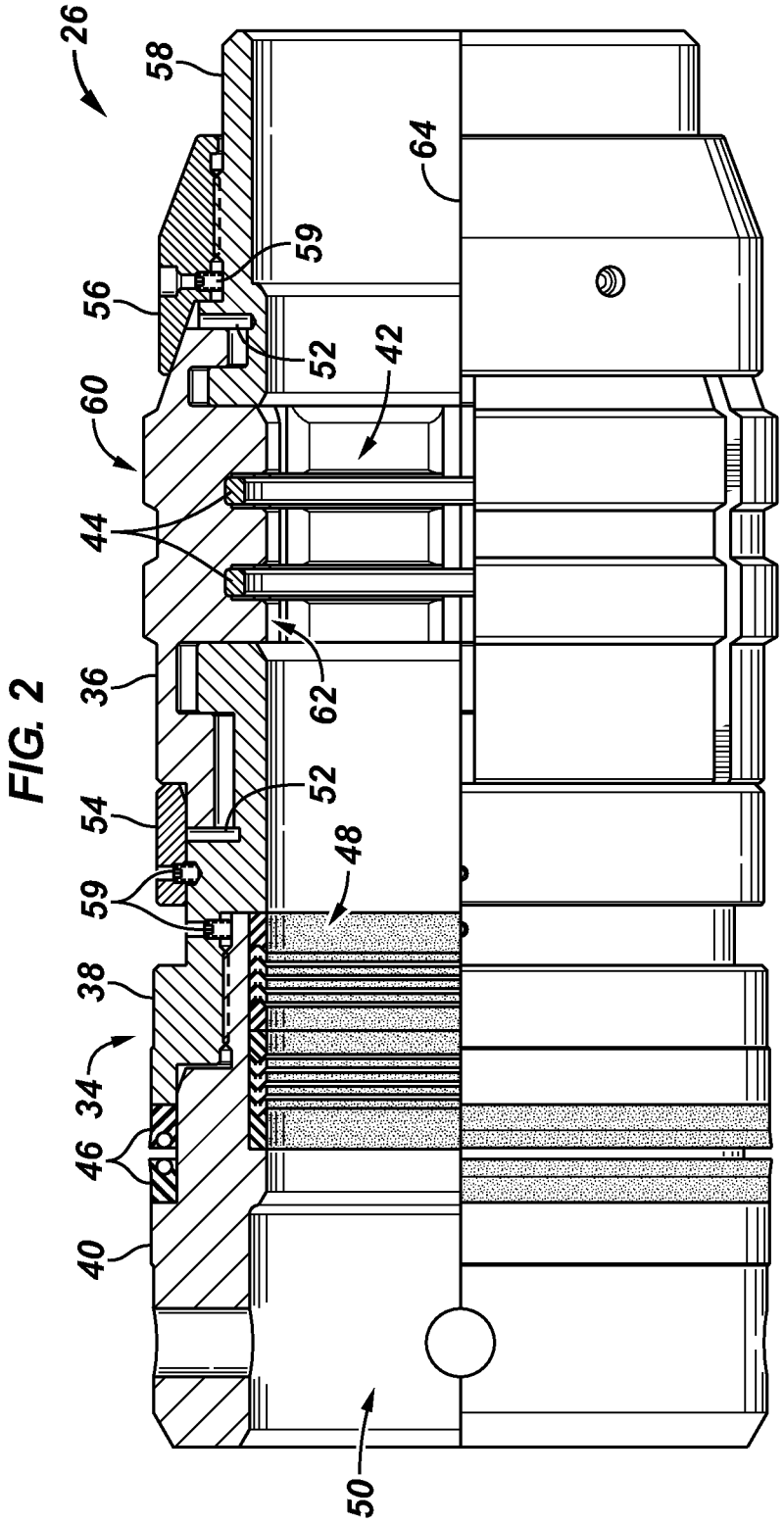
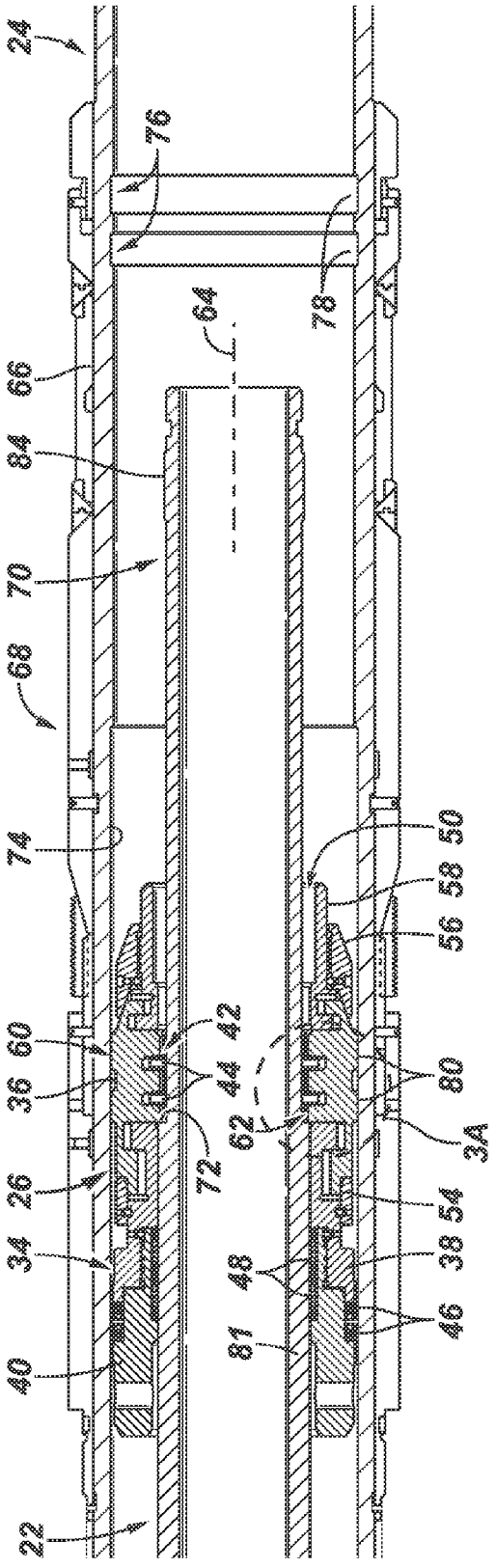


FIG. 2


24
76
78
64
66
84
70
68
74
50
58
56
60
42
36
44
62
80
3A
72
26
54
34
38
48
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81
40
22

FIG. 3

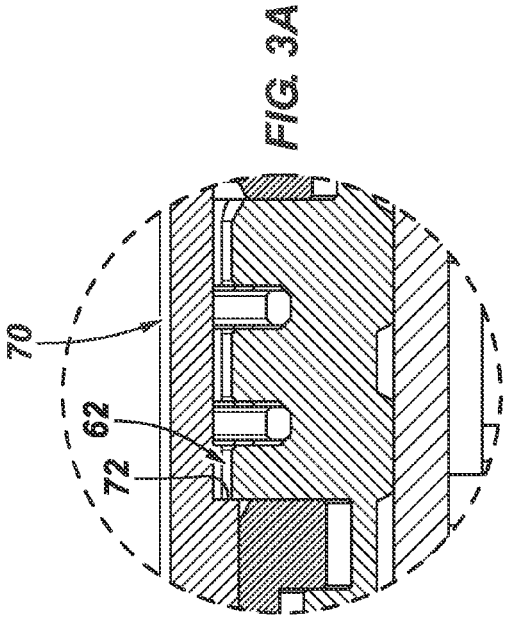
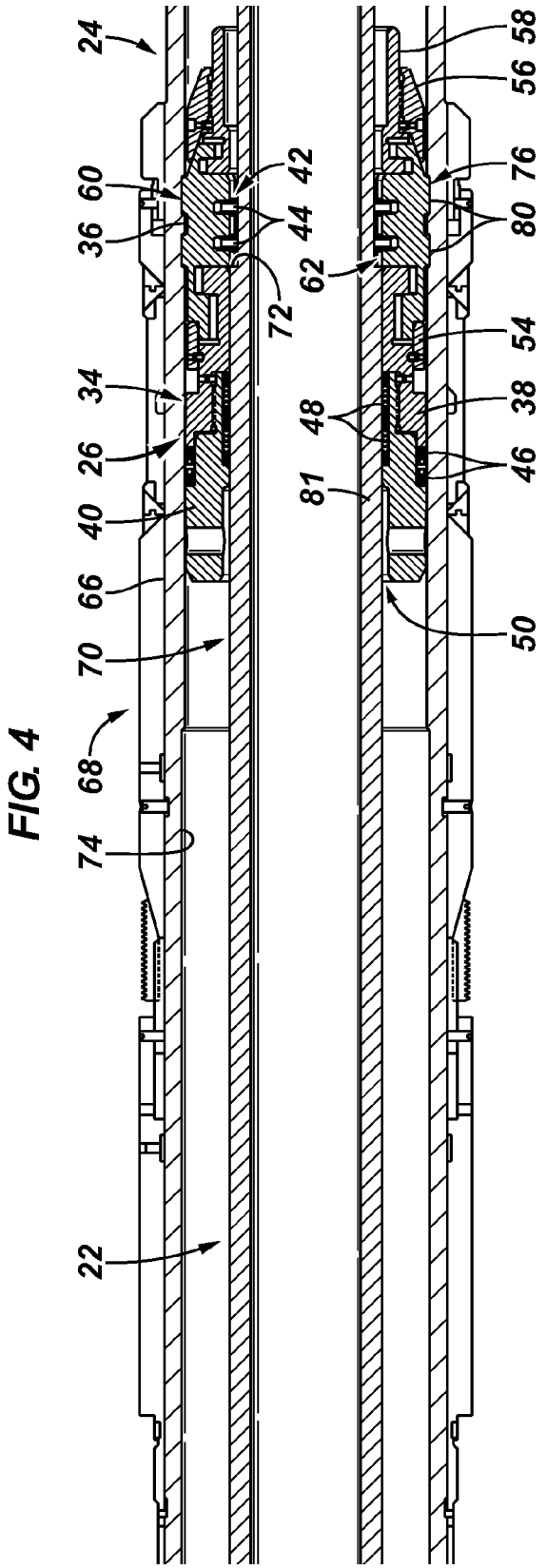

70
62
72

FIG. 3A


24
60
36
42
44
72
34
26
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66
70
68
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76
80
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38
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46
81
50

FIG. 4

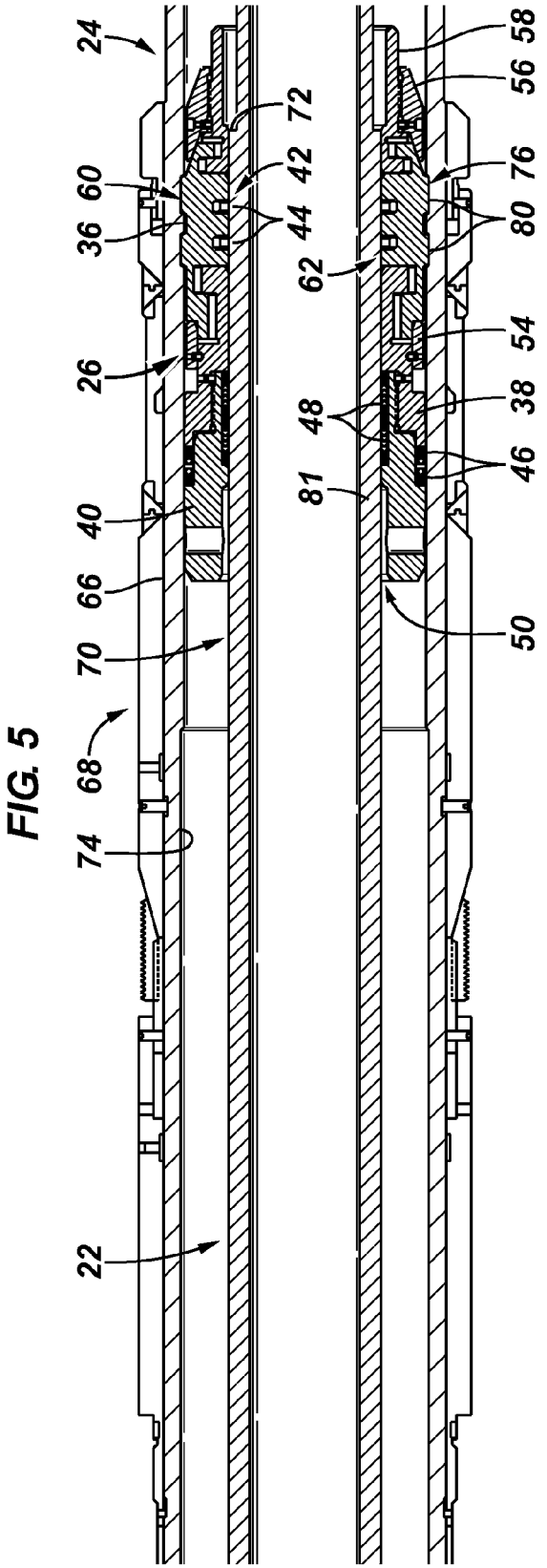

FIG. 5

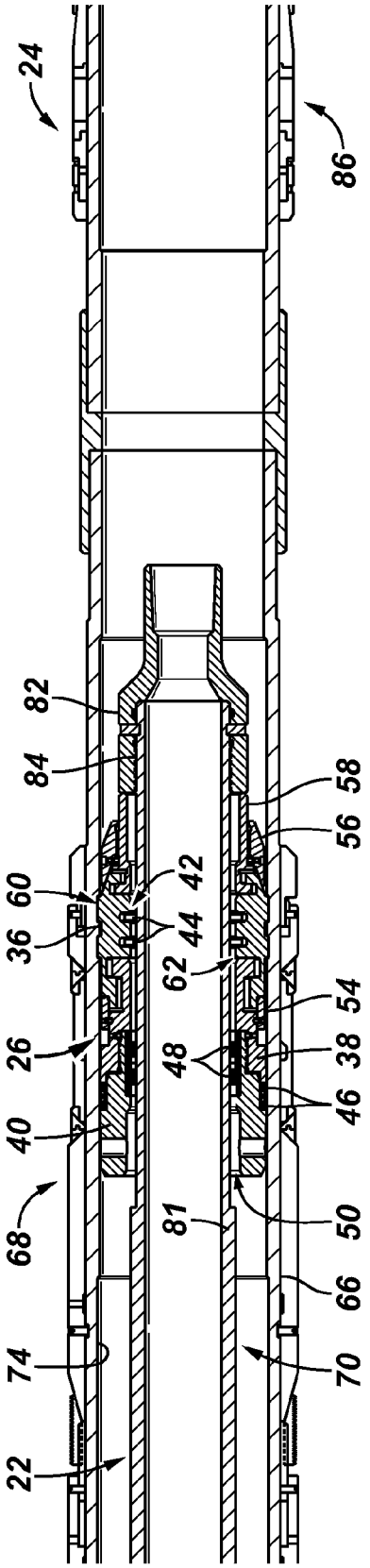

FIG. 6

RETRIEVABLE CEMENTING BUSHING SYSTEM

BACKGROUND

Hydrocarbon fluids such as oil and natural gas are obtained from a subterranean geologic formation, referred to as reservoir, by drilling a well that penetrates the hydrocarbon-bearing formation. In a variety of downhole applications, casing and/or liners are deployed down along the wellbore and cemented into place. A setting tool string is deployed down through the liners with an appropriate service tool to facilitate the desired service operations, e.g. cementing of the liner or liners within the wellbore. In some applications, the tool string comprises a retrievable cementing bushing which provides a seal against pressure and prevents cement from backing up through an interior of the liner hanger.

SUMMARY

In general, the present disclosure provides a system and method for facilitating a downhole service operation, such as a cementing operation. A retrievable cementing bushing (RCB) is designed to facilitate the service operation and includes a body on which is mounted an engagement lug. The engagement lug is movably mounted for movement in a radial direction and includes an outer engagement feature and an inner engagement feature, e.g. engagement shoulder. The inner engagement feature is oriented for cooperation with a slick joint. The engagement lug is biased in a radially outward direction for engagement with corresponding features of a surrounding wall, e.g. a surrounding packer body wall.

However, many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Certain embodiments will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein, and:

FIG. **1** is an illustration of an embodiment of a well system having a tool string with an RCB, according to an embodiment of the disclosure;

FIG. **2** is a partial cross-sectional view of an example of an RCB, according to an embodiment of the disclosure;

FIG. **3** is an illustration of an example of an RCB disposed within a tubular well system, e.g. liner system, according to an embodiment of the disclosure;

FIG. **3**A shows detail of a portion of the RCB disposed within a tubular well system illustrated FIG. **3**.

FIG. **4** is an illustration similar to FIG. **3** but showing the RCB at a different position within the tubular well system, according to an embodiment of the disclosure;

FIG. **5** is an illustration similar to FIG. **4** but showing a slick joint at a different position within the RCB, according to an embodiment of the disclosure; and

FIG. **6** is an illustration similar to FIG. **4** but showing the slick joint at a different position within the RCB, according to an embodiment of the disclosure.

DETAILED DESCRIPTION

In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. However, it will be understood by those of ordinary skill in the art that the system and/or methodology may be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

The disclosure herein generally involves a system and methodology related to performing service operations in a borehole. By way of example, the system and methodology may be used to facilitate cementing operations in wellbores. In this latter example, a tool string is delivered downhole within a surrounding well system, such as a surrounding liner system. The tool string may comprise a variety of components, including a retrievable cementing bushing (RCB). In cementing operations, the RCB provides a seal within the surrounding well system and serves to hold against pressure and to prevent cement slurry from backing up through an interior of the liner hanger. The RCB thus helps force the cement slurry into the annulus surrounding the liner system to facilitate cementing of the liner. However, the RCB can be used with a variety of tool strings and within many types of surrounding well systems depending on the parameters of a given well servicing application.

According to an embodiment of the disclosure, the RCB is resettable in a manner that allows it to be automatically set at a desired location and then reset if prematurely removed from the desired location. By way of example, the RCB may comprise a bushing body on which is mounted a radially movable engagement lug. The engagement lug comprises engagement features by which it engages corresponding features in the surrounding well system when delivered down through the well system via the tool string. The engagement lug maybe a single lug or a plurality of lugs that are spring biased in the radially outward direction. Radially movable refers to the capacity for outward or inward movement of the engagement lug relative to a longitudinal axis of the RCB. The actual path along which the engagement lug moves may be along a path perpendicular to the axis of the RCB or along a different path, e.g. an arcuate path, resulting in movement in the radial direction.

In some applications, the engagement lug also may comprise a radially inward feature designed for engagement with an internal slick joint which may be moved through an internal longitudinal passage of the RCB. The radially inward feature extends inwardly and provides a shoulder or other type of feature to engage a corresponding shoulder or feature of the slick joint. However, once the RCB is moved to the desired location and the engagement lug is moved radially outward into engagement with the corresponding features of the surrounding well system, the slick joint may pass through the RCB unobstructed. If the RCB and the engagement lug are inadvertently pulled from the desired location and from engagement with the corresponding features, the slick joint may again be moved into abutting engagement with the radially inward feature of the engagement lug. This allows the slick joint to be used in moving the RCB back to the desired location for automatic resetting at the desired location.

Referring generally to FIG. **1** a well system is illustrated as comprising a tool string carrying an RCB. The well system can be used in a variety of well applications, including onshore applications and offshore applications. In this example, the tool string is deployed in a surrounding tubular well system, such as a liner system. However, the tool string and the RCB may be used in a variety of other tubular systems and other applications.

In the example illustrated, an overall well system **20** is illustrated as comprising a tool string **22** deployed into a surrounding tubular system **24** positioned within a wellbore

25. By way of example, the tubular system **24** may comprise a liner system. In this embodiment, the tool string **22** comprises a variety of components, including a retrievable cementing bushing (RCB) **26**. Depending on the application, the tool string **22** may comprise other types of components, such as a hydraulic running tool **28**, an internal packer **30**, and a junk bonnet **32**. The various components may be connected together by a variety of subs and/or other components depending on the parameters of a given well servicing application. In the example illustrated, the RCB **26** is designed to form a seal within tubular system **24**, e.g. within a liner system.

Referring generally to FIG. **2**, an example of the RCB **26** is illustrated. In this embodiment, the RCB **26** comprises a body **34** to which an engagement lug **36** is movably mounted. The engagement lug **36** may be mounted for radial movement between a radially inward or retracted position and a radially extended position, as illustrated. The path of radial movement may be straight, angular, and/or curved depending on the design of body **34** and engagement lug **36**. In the embodiment illustrated, engagement lug **36** is mounted to a center body portion **38** which is designed to guide the engagement lug **36** when moving in the radial direction. However, body **34** may comprise other components, such as a top adapter **40**. The engagement lug **36** may be formed as an individual lug or as a plurality of lugs separately mounted for movement in a radial direction. In FIG. **2**, the engagement lug **36** is illustrated as a plurality of engagement lugs positioned circumferentially around body **34**.

In the embodiment of FIG. **2**, the engagement lug **36** is biased to move in a radially outward direction. By way of example, the engagement lug **36** may be biased via a spring member **42** although other biasing mechanisms, e.g. pressurized fluid, also may be used to bias the engagement lug **36** outwardly. Spring member **42** may comprise a variety of springs, such as a C-spring **44**. In the embodiment illustrated, a plurality of C-springs, e.g. two C-springs, is employed and disposed within internal recesses formed along an interior surface of the engagement lug **36**.

The RCB **26** also may comprise a variety of other components to facilitate cementing or other servicing operations. For example, the RCB **26** may comprise an outer seal or seals **46** designed to form a seal between the RCB **26** and a surrounding well system surface. An internal seal or seals **48** may be located along an internal, longitudinal passage **50** extending through the RCB **26**. The internal seal **46** is positioned to form a seal between the RCB **26** and an internal slick joint slidably received along the longitudinal passage **48**, as described in greater detail below.

Depending on the overall design of RCB **26**, a variety of other features may be employed. For example, the engagement lug **36** may be slidably mounted between pins **52**. Additionally, the movable engagement lug **36** may be retained by a top ring **54** and a bottom ring **56**. The bottom ring **56** is secured to a nose member **58** which also may be designed to guide the engagement lug **36** when moved along its radially oriented path between retracted and extended positions. Various fasteners, such as set screws **59**, may be used to secure center body portion **38** to top adapter **40**, top ring **54** to center body portion **38**, and bottom ring **56** to nose member **58**. However, the type, number and design of the various components used to form RCB **26** may be adjusted according to a given application.

The embodiment illustrated in FIG. **2** utilizes an outer engagement feature **60** located on a radially outer surface of the engagement lug **36**. The radially outward engagement feature **60** is designed to engage a corresponding feature of the surrounding tubular system **24**. Spring member **42** biases engagement lug **36** in the radially outward direction and moves lug **36** radially outward once outer engagement feature **60** is translated into position at the corresponding engagement feature. Additionally, the engagement lug **36** may comprise an inner engagement feature **62** located on a radially inward surface of the engagement lug **36** for exposure to longitudinal passage **50**. By way of example, the radially inward engagement feature **62** may comprise a shoulder, e.g. a sharp edged shoulder having an engagement surface oriented approximately perpendicular to a longitudinal axis **64** of RCB **26**. The engagement feature **62** is designed to abut a corresponding engagement feature of a slick joint, as described in greater detail below.

In FIG. **3**, the RCB **26** is illustrated in an operational example in which the RCB **26** is disposed within tubular system **24**. In this example, the RCB **26** is illustrated as moving along the interior of a packer body **66** of a packer **68**. The packer **68** can be part of tubular system **24** which may be in the form of a liner system. For example, packer **68** may be positioned in liner system **24** above a liner hanger or other component of the liner system **24**.

A slick joint **70** is illustrated as slidably positioned through RCB **26** along the internal, longitudinal passage **50**. The slick joint **70** comprises an external engagement feature **72** designed to engage the inner engagement feature **62** of the engagement lug **36**. By way of example, external engagement feature **72** may comprise a shoulder, such as a sharp edged shoulder designed to abut inner engagement feature **62** along a surface oriented generally perpendicular to axis **64** of RCB **26** and slick joint **70**.

As illustrated in FIG. **3**, the outer engagement feature **60** of engagement lug **36** slides along an internal surface **74** of the tubular system **24** prior to reaching a corresponding engagement feature **76**. In the example illustrated, corresponding engagement feature **76** is disposed along internal surface **74** of packer body **66**. Although the corresponding engagement feature **76** may be structured in a variety of forms, the illustrated example shows a plurality of annular recesses **78** designed to receive a plurality of annular extensions **80** which may be used to form outer engagement feature **60** of engagement lug **36**. It should be noted the RCB **26** can be used in other locations, e.g. in other subs along the well system, and is not limited to being used within the packer body **66**. As illustrated, the engagement lug **36** is held radially inward at a radially retracted position as it slides along internal surface **74**. When in this radially retracted position, engagement feature **62** extends a sufficient distance into longitudinal passage **50** to enable secure engagement with external engagement feature **72** of the slick joint **70**, as shown in FIG. **3**A. Accordingly, the slick joint **70** may be used to move the RCB **26** along the interior of tubular system **24** at least until engagement lug **36** is received in engagement feature **76**, as illustrated in FIG. **4**.

Referring generally to FIG. **4**, once the engagement lug **36** reaches engagement feature **76**, spring member **42** forces the engagement lug **36** to a radially extended position. For example, spring member **42** moves the engagement lug **36** in a radially outward direction to engage the outer engagement feature **60** with the corresponding engagement feature **76** of the tubular system **24**. When the engagement lug **36** is forced radially outward into engagement with the corresponding engagement feature **76**, the inner engagement feature **62** also moves radially outward to allow passage of the slick joint engagement feature **72**, as illustrated in FIG. **5**. In this latter operational position, the RCB **26** is locked in place at the desired location within tubular system **24** by a larger diameter

portion **81** of slick joint **70**. In the position illustrated in FIG. **5**, the larger diameter portion **81** prevents movement of engagement lug **36** in a radially inward direction. While RCB **26** is locked at the desired location, slick joint **70** may be selectively moved along the internal, longitudinal passage **50** to facilitate performance of the desired servicing operation, e.g. cementing operation.

Upon completion of the servicing operation or during a transition between stages of the servicing operation, the RCB **26** may be retrieved or moved back along the tubular system **24** via a retrieval device **82**, as illustrated in FIG. **6**. The retrieval device **82** may be attached to a distal end **84** of slick joint **70**. In this example, picking up of the slick joint **70** causes slick joint engagement feature **72** to move back past inner engagement feature **62** of engagement lug **36** which serves to unlock the engagement lug **36**. This allows retrieval device **82** to apply force against the RCB **26** during continued lifting of slick joint **70** so as to force engagement lug **36** to its radially retracted position. Once engagement lug **36** is in its radially retracted position, the RCB **26** may be slid along internal surface **74**.

In the event that retrievable cementing RCB **26** is inadvertently moved away from engagement feature **76**, the features of RCB **26** enable resetting of the RCB **26** at the desired location of engagement feature **76**. For example, the continued radially outward bias applied by spring member **42** enables the engagement lug **36** to be moved radially outward once the outer engagement feature **60** is again positioned at the corresponding engagement feature **76**. Additionally, the inner engagement feature **62** enables movement of the RCB **26** back to the desired location at engagement feature **76** via engagement with the corresponding engagement feature **72** of slick joint **70**. Slick joint **70** may simply be moved back down through tubular system **24** so that the engagement feature **72**, e.g. shoulder feature **72**, engages RCB **26** via feature **62** to enable movement of the RCB **26** back to its desired location. If necessary, the RCB **26** may be reset in this manner multiple times.

The RCB **26** may be employed in a variety of service applications. By way of example, RCB **26** may be used with tubular system **24** in the form of a liner system to facilitate pressure tests, setting of packers, and other functions during a cementing procedure. In FIG. **6**, for example, the RCB **26** is illustrated as designed for engagement within packer **68** which, in turn, is positioned above a liner hanger **86**. However, RCB **26** may be used at other locations and within other types of devices.

In the embodiment illustrated, RCB **26** allows the tool string **22** to be stroked for the running of pressure tests and the setting of packers. However, if the RCB **26** is dislodged during these procedures, the slick joint **70** may be used to reset the RCB **26** as described above.

Depending on the downhole application, the embodiments described herein may be used to facilitate cementing operations and/or a variety of other servicing operations. In wellbore related applications, the overall well system may comprise many types of components and arrangements of components. Additionally, the tubular system **24** may be used with a variety of devices and systems, including a variety of packers, subs, flow control devices, sensors and other components designed to facilitate the given servicing operation. The specific components and arrangements of components used to form the RCB also may be constructed in various designs and configurations depending on the parameters of a given well related application or other type of application.

Although a few embodiments of the system and methodology have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

What is claimed is:

1. A system to facilitate a cementing operation in a wellbore, comprising a tool string disposed in a surrounding liner system, the tool string having a slick joint slidably received along an internal longitudinal passage of a retrievable cementing bushing, the retrievable cementing bushing comprising an engagement lug biased to move in a radially outward direction, the engagement lug having an internal shoulder oriented for engagement with an external shoulder on the slick joint to facilitate resetting of the retrievable cementing bushing in the surrounding liner system, the engagement lug further comprising a radially outward engagement feature oriented for engagement with a corresponding feature of a packer of the surrounding liner system.

2. The system as recited in claim **1**, wherein the retrievable cementing bushing comprises a spring member to bias the engagement lug in the radially outward direction.

3. The system as recited in claim **2**, wherein the spring member comprises a C-spring.

4. The system as recited in claim **2**, wherein the spring member comprises a plurality of C-springs.

5. The system as recited in claim **1**, wherein the retrievable cementing bushing comprises a body which movably receives the engagement lug in a manner which allows radially oriented movement of the engagement lug.

6. The system as recited in claim **1**, wherein the engagement lug is formed as a plurality of engagement lugs which are radially movable.

7. A method, comprising:

preparing a retrievable cementing bushing with a body;

movably mounting an engagement lug on the body such that an outer engagement feature is oriented radially outward and an inner engagement feature is oriented radially inward;

spring biasing the engagement lug in a radially outward direction with respect to the body;

positioning a slick joint within the retrievable cementing bushing and orienting a slick joint engagement feature of the slick joint to abut the inner engagement feature of the engagement lug along a surface substantially perpendicular to an axis of the slick joint; and

moving the retrievable cementing bushing into a packer until the outer engagement feature is received in a corresponding internal engagement feature of the packer.

8. The method as recited in claim **7**, further comprising using the slick joint engagement feature to reset the retrievable cementing bushing within the packer after being disconnected.

9. The method as recited in claim **7**, wherein spring biasing comprises using a C-spring member.

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